

ASSESSING CHEMICAL INTEGRITY IN THE GREAT LAKES BASIN

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OUTLINE

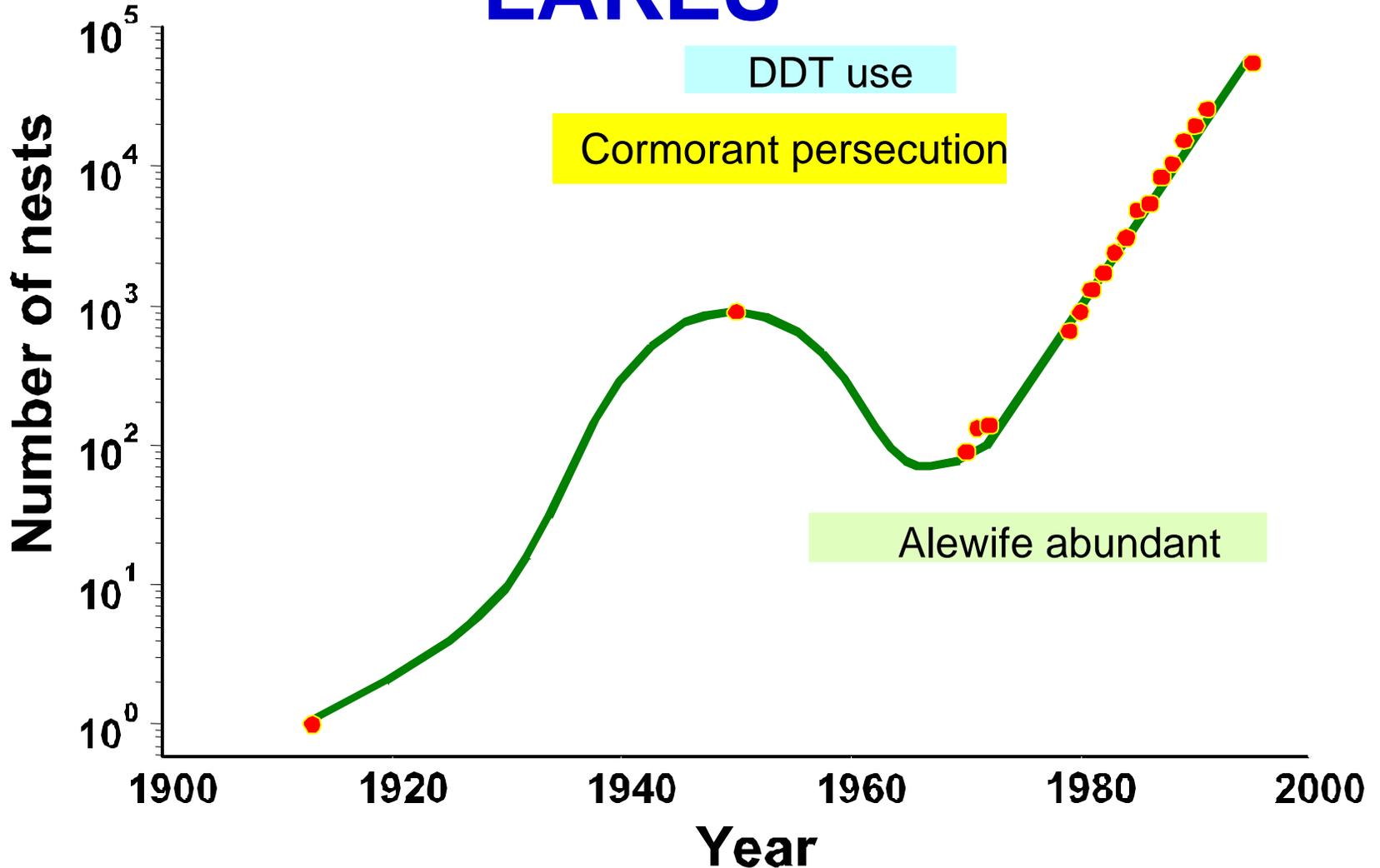
- Identifying chemicals of concern
- Identifying sources
- Assessing effects
- Assessing risks of chemicals of concern
- Toxicity, hazard and risk
- Dealing with mixtures
- Conclusions



IDENTIFYING CHEMICALS OF CONCERN

- The chemical is in the system
 - So what?
- By analogy because the chemical is in other systems
 - Other systems are different?
- Must avoid Type-3 errors

CORMORANTS IN THE GREAT LAKES



Data from Weseloh et al, 1995

RESIDUES IN ORGANISMS

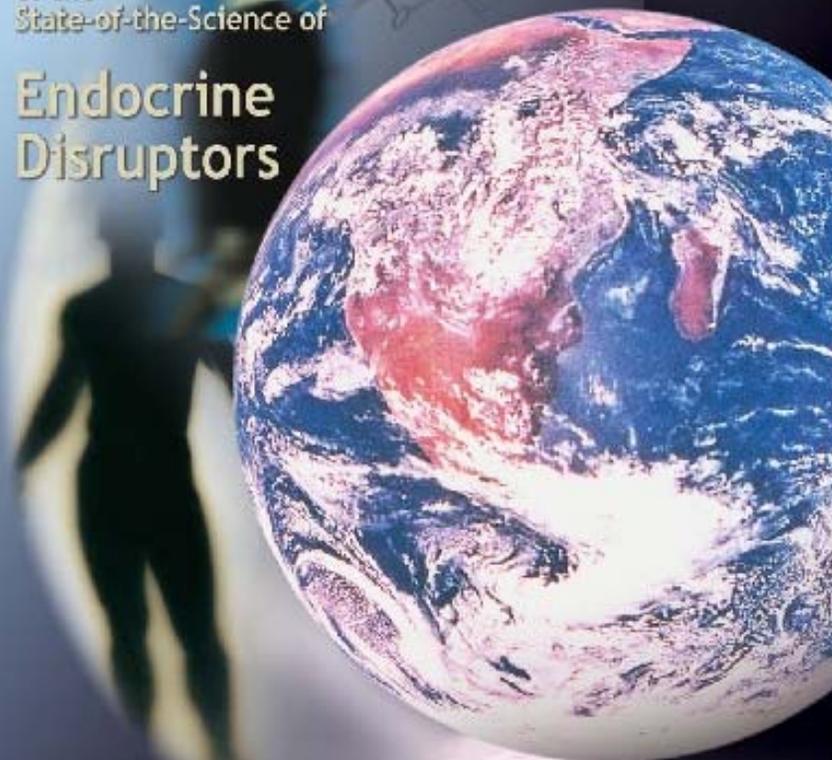
- Presence in the organism does not mean that it is causing a problem.
 - Canadian “Toxic Nation” report.
- Presence in the matrix does not mean that it is causing a problem.

Global Assessment

of the
State-of-the-Science of

Endocrine Disruptors

WHO/PCS/EDC/02.2



Edited by

Terri Damstra

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Glen Van Der Kraak

IPCS

INTERNATIONAL PROGRAMME
ON CHEMICAL SAFETY



CAUSAL CRITERIA FOR ASSESSING ENDOCRINE DISRUPTORS: A PROPOSED FRAMEWORK

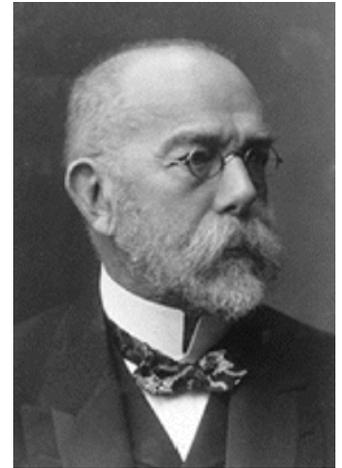
IPCS. 2002. Global Assessment of the State-of-the-Science of Endocrine Disruptors. Geneva, Switzerland: International Programme on Chemical Safety of the World Health Organization Report No.

WHO/PCS/EDC/02.2. August 2002. <http://www.who.int/pcs>

GUIDELINES FOR CAUSALITY

- Temporality
- Strength of association
- Consistency
- Biological plausibility
- Recovery

Koch



Hill



Doll

Koch R. 1882. Die Aetiologie der Tuberculose. In: Clark DH, ed. *Source Book of Medical History*. Dover Publications, Inc. p 392–406

Hill AB. 1965. The environment and disease: association or causation? *Proc. Roy. Soc. Med.* 58:295-300

CAUSE FOR WORRY

- The concentrations are increasing
 - PBDEs
 - PFOA and PFCs
 - Pharmaceuticals
- The substance biomagnifies
 - PBDEs, not tetrabromobisphenol A
 - PFOA/ long chain PFCs
- The substance is persistent or pseudopersistent
 - PBDEs
 - PFCs
 - Pharmaceuticals

IDENTIFYING SOURCES

- Where is it coming from?
- Can we do anything about it?
 - Process changes
 - Source mitigation

PULP MILL EFFLUENTS

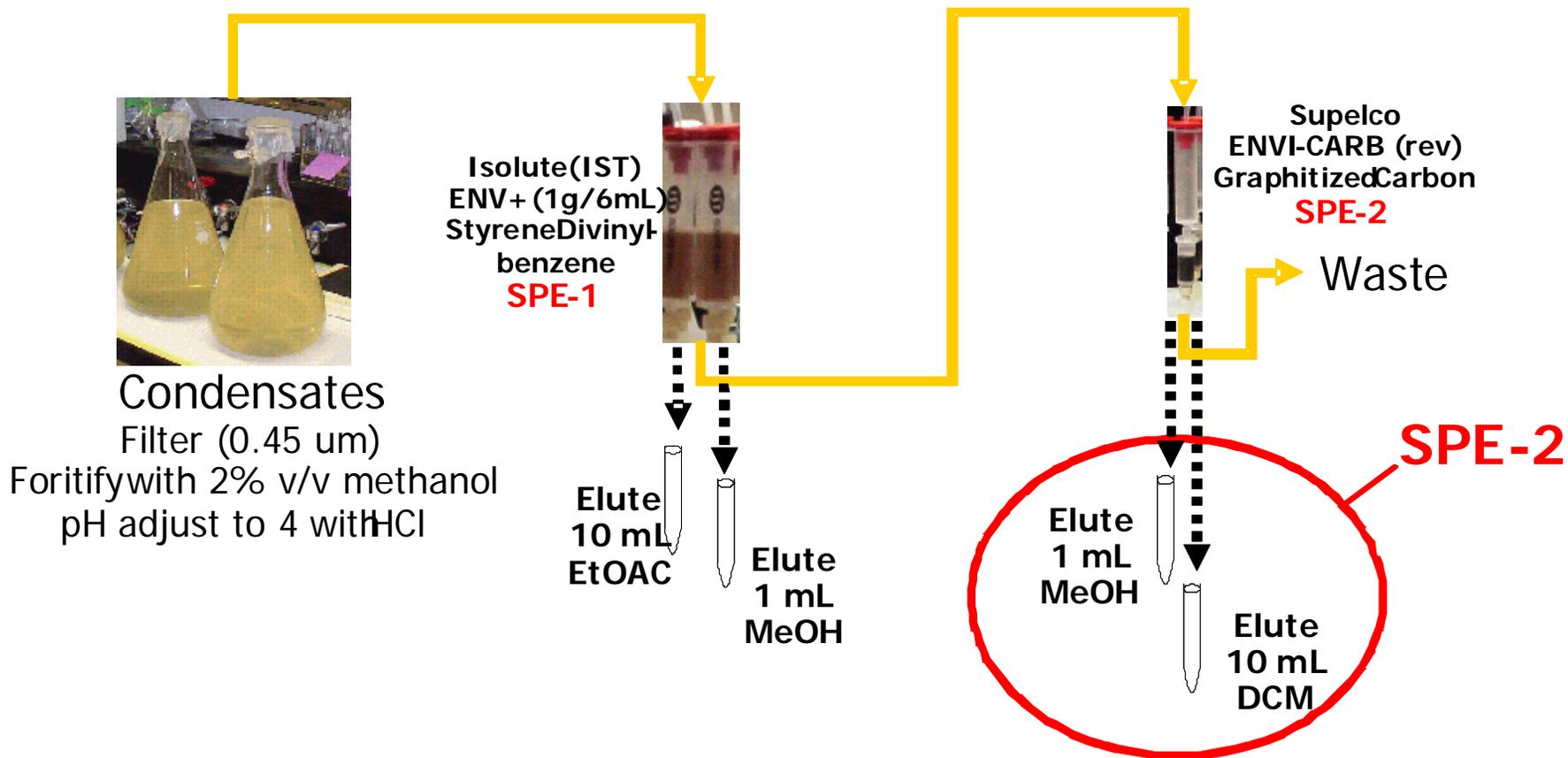


EFFECTS IN FISH

	MFO		STEROIDS		LIVER SIZE
	M	F	M	F	
No chlorine	↑	■	■	↓	↑
	↑	■	■	■	↑
	NA	NA	NA	NA	NA
Chlorine, no 2nd treatment	↑	↑	↓	↓	■
	↑	↑	↓	↓	■
	↑	↑	NA	NA	NA
	↑	↑	NA	NA	NA
Chlorine, 2nd treatment	↑	↑	↓	↓	↑
	↑	↑	↓	↓	↑
	↑	↑	↓	↓	↑

Data from Robinson et al, 1994

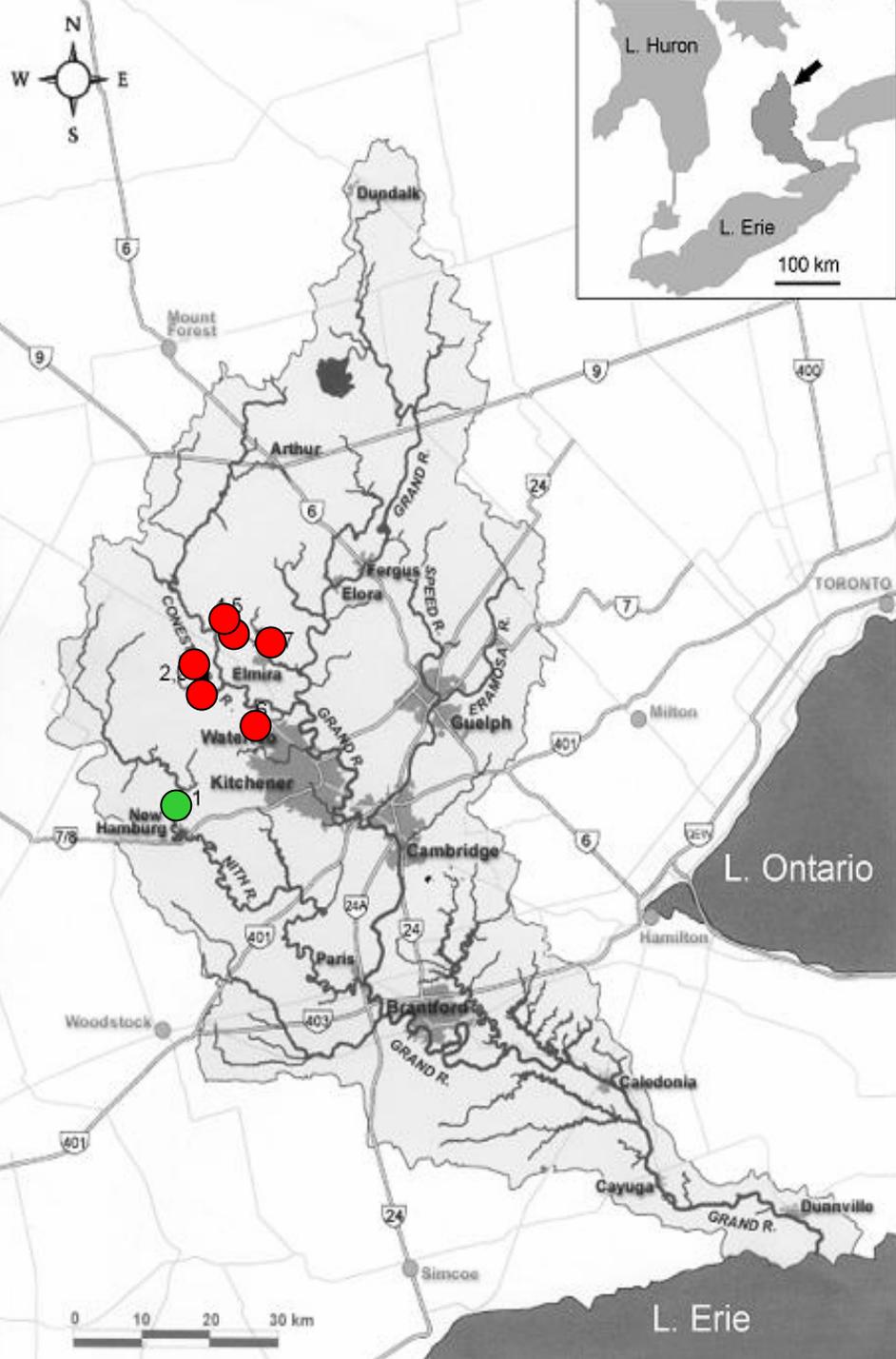
IDENTIFYING THE KEY FRACTION



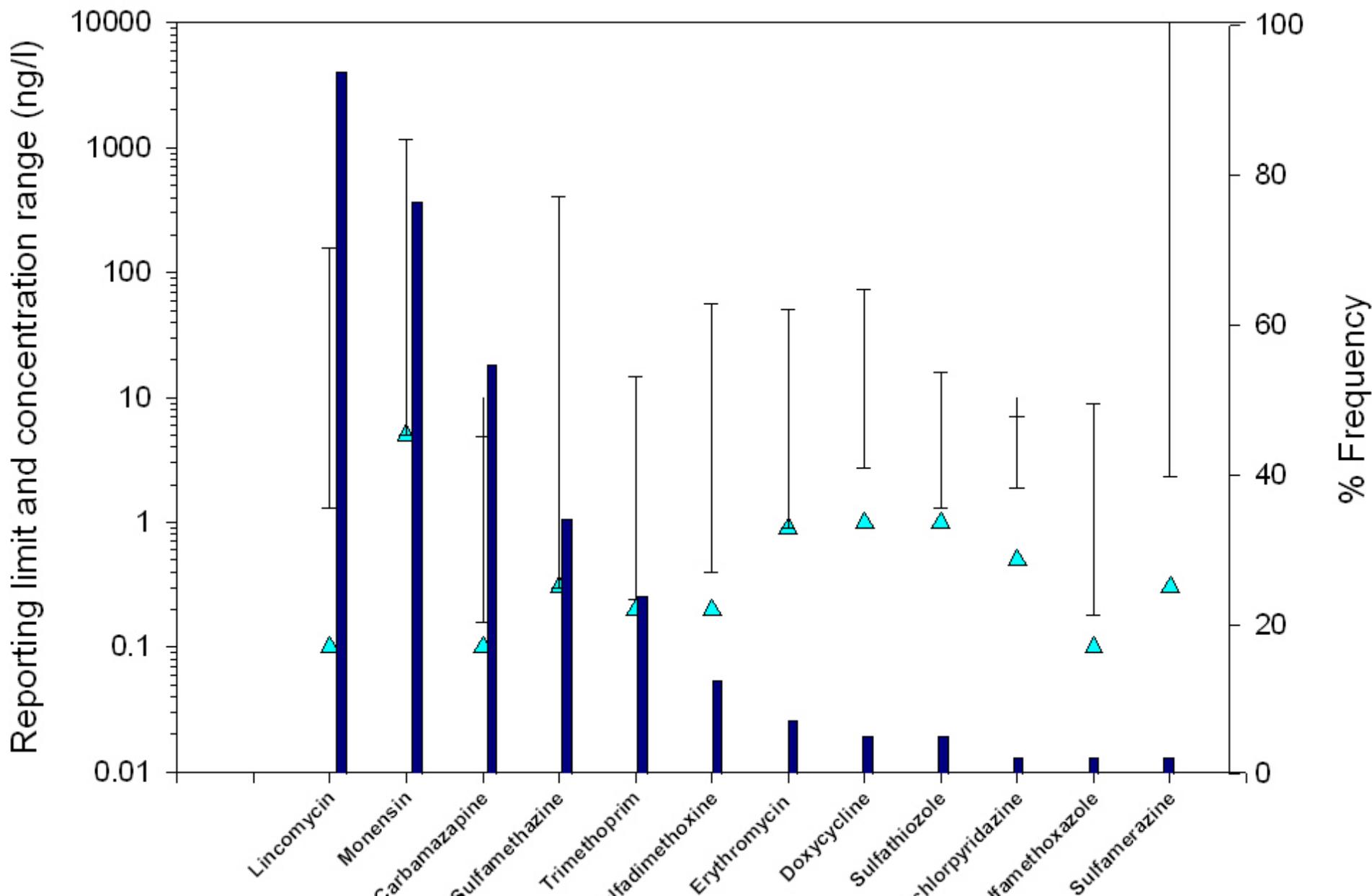
Hewitt ML, Smyth SAM, Dube MG, Gilman CI, Maclatchy DL. 2002. Isolation of compounds from bleached kraft mill recovery condensates associated with reduced levels of testosterone in mummichog (*Fundulus heteroclitus*). Environ Toxicol Chem 21:1359–1367.

AGRICULTURAL PHARMACEUTICALS





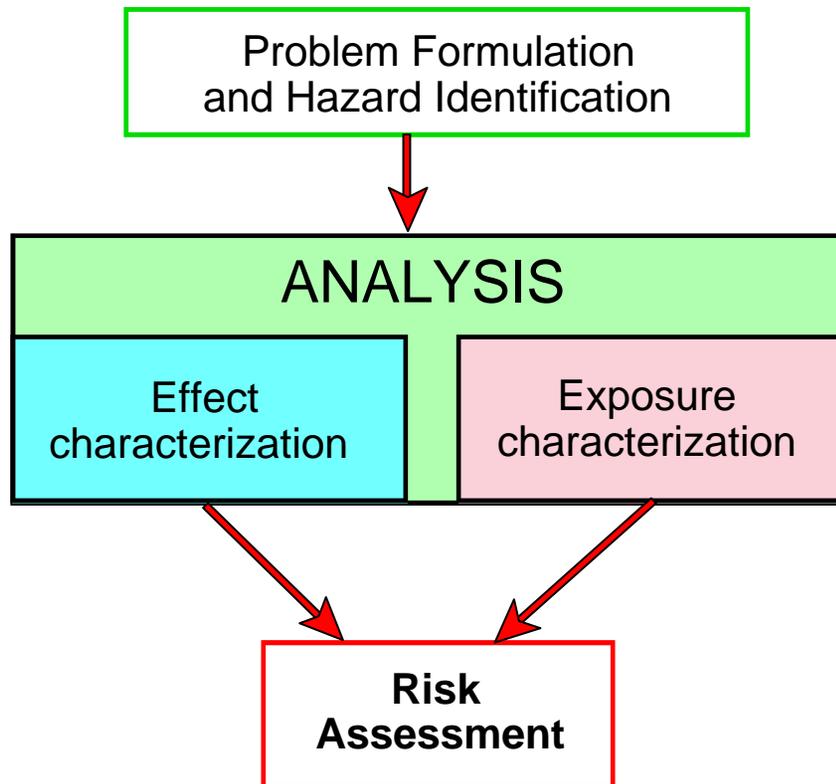
Agricultural Surface Waters (n=97)



ASSESSING RISKS OF CHEMICALS OF CONCERN

- Frameworks for risk assessment

RISK ASSESSMENT

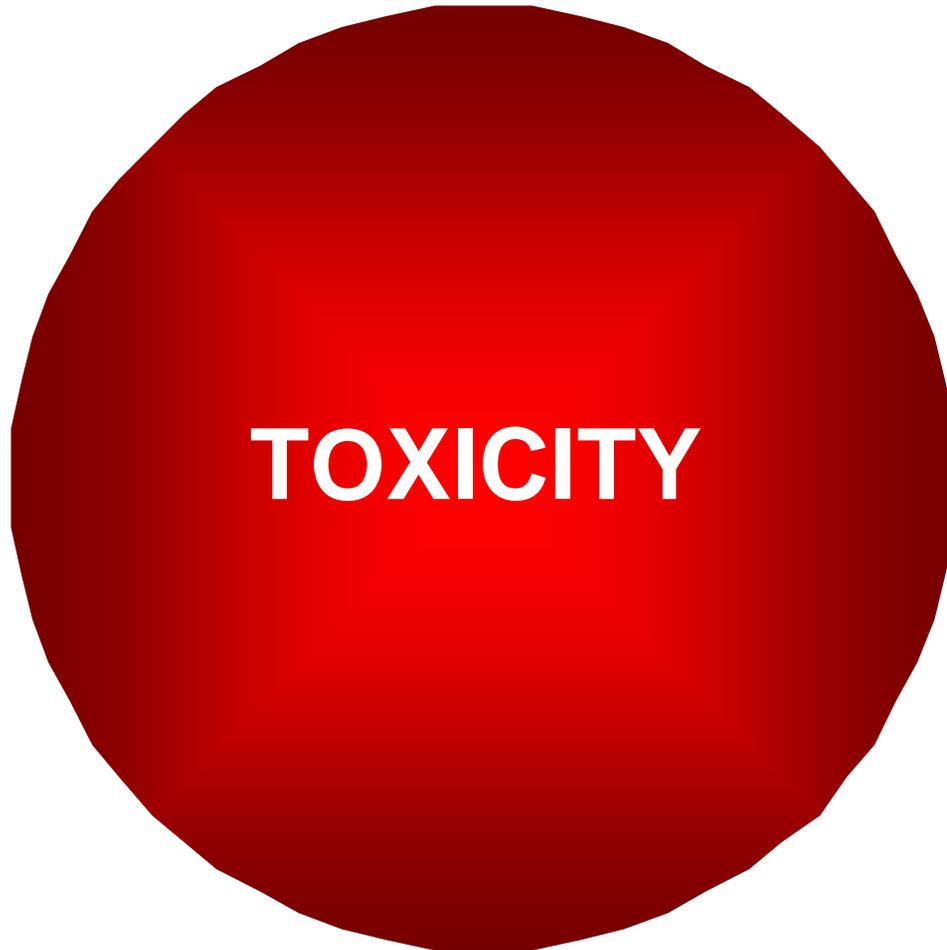


USEPA 1998

TOXICITY, HAZARD, AND RISK

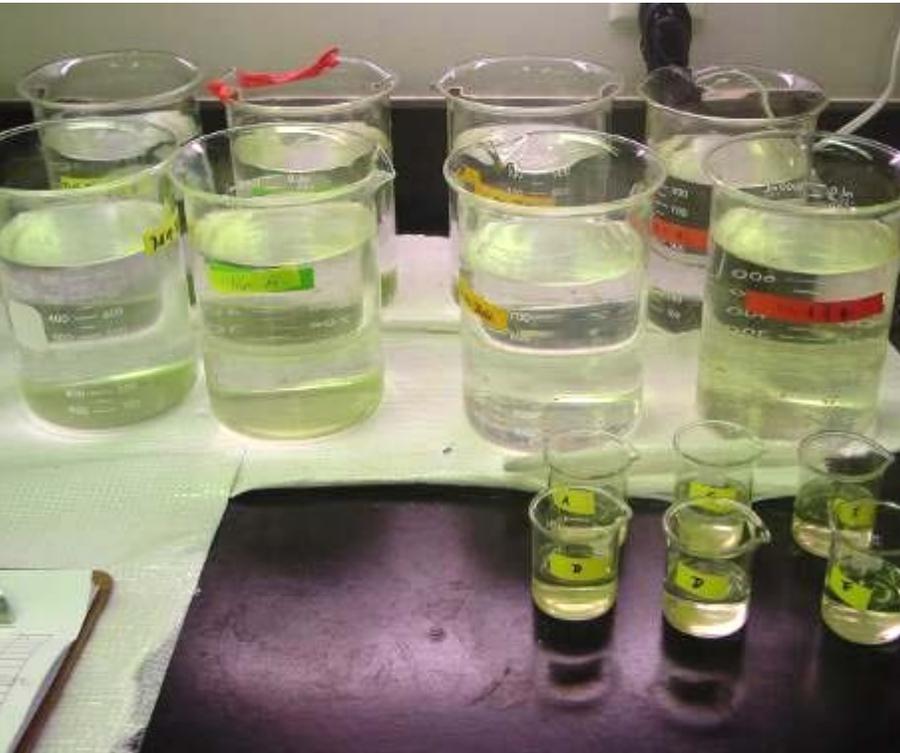
- Toxicity is not Hazard is not Risk

Ranking of concerns in the absence of
exposure information

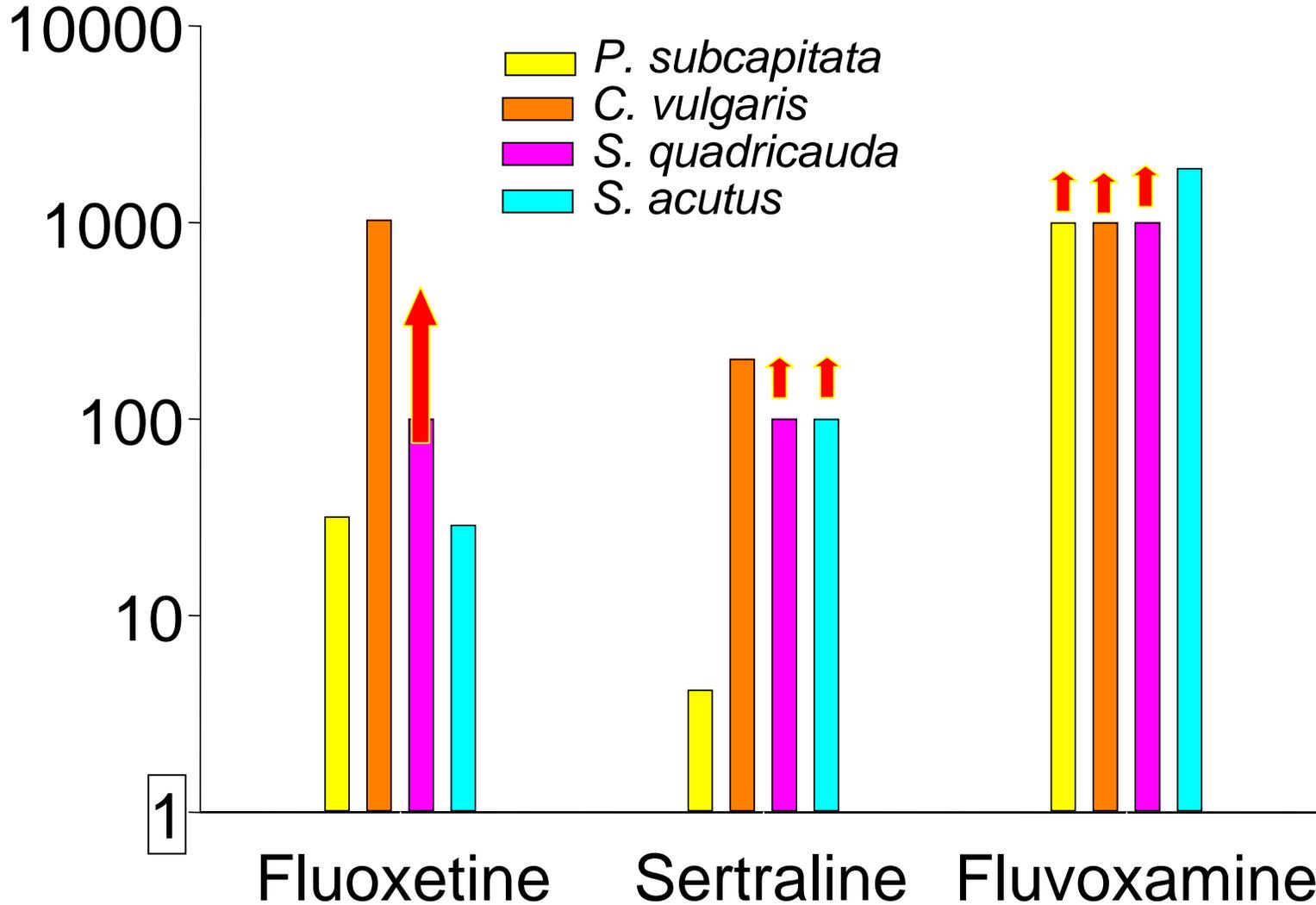


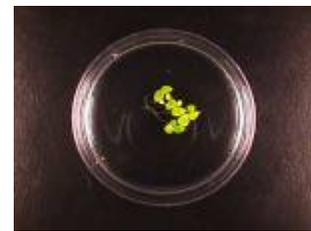
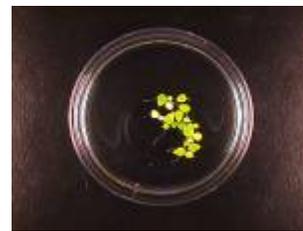
EFFECTS CHARACTERIZATION

- Laboratory studies
 - Surrogate species with standard protocols
 - Mechanisms of action
 - Simple mixtures



ACUTE GROWTH INHIBITION ASSAYS





CON

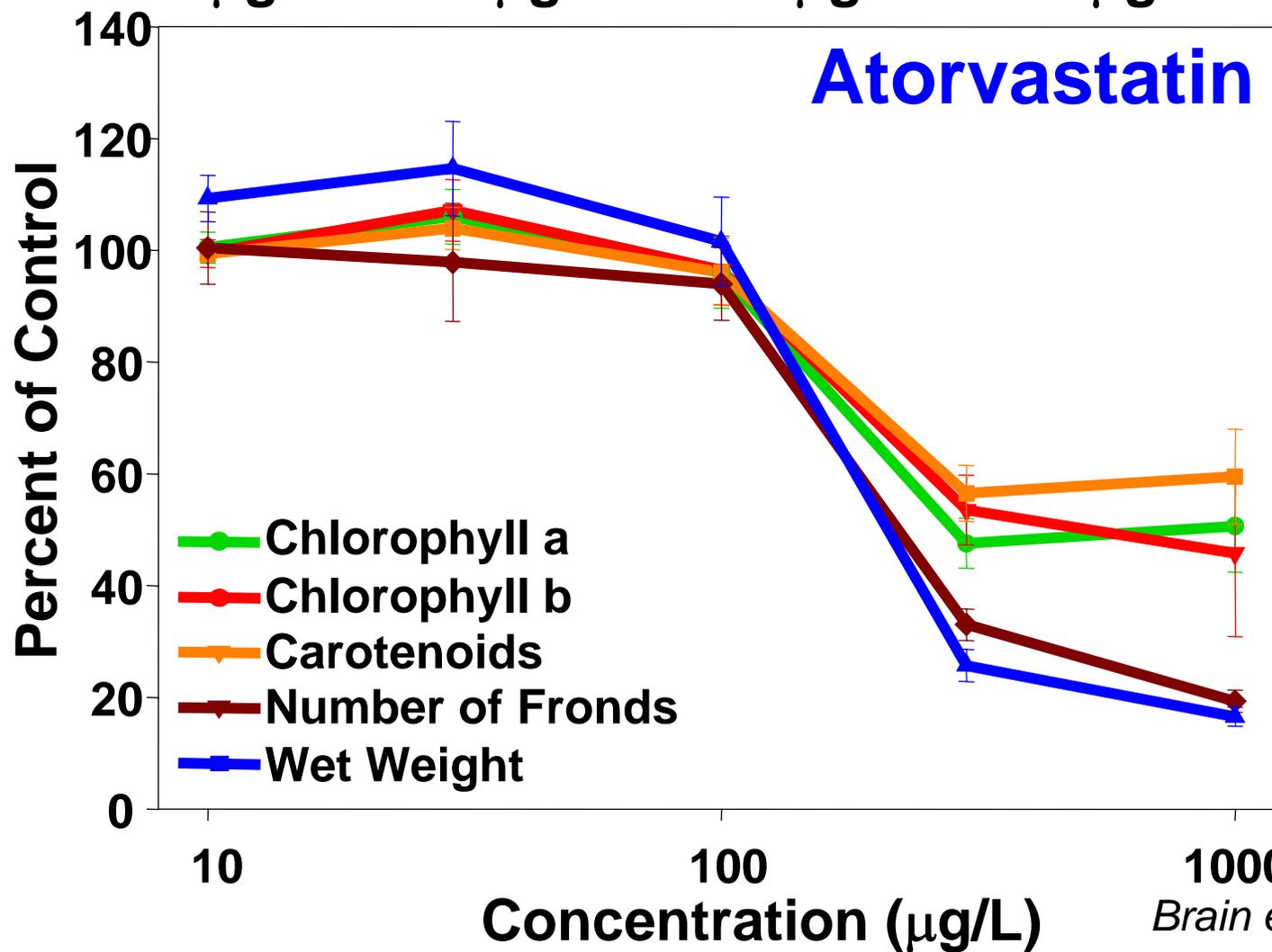
10µg/L

30µg/L

100µg/L

300µg/L

1000µg/L



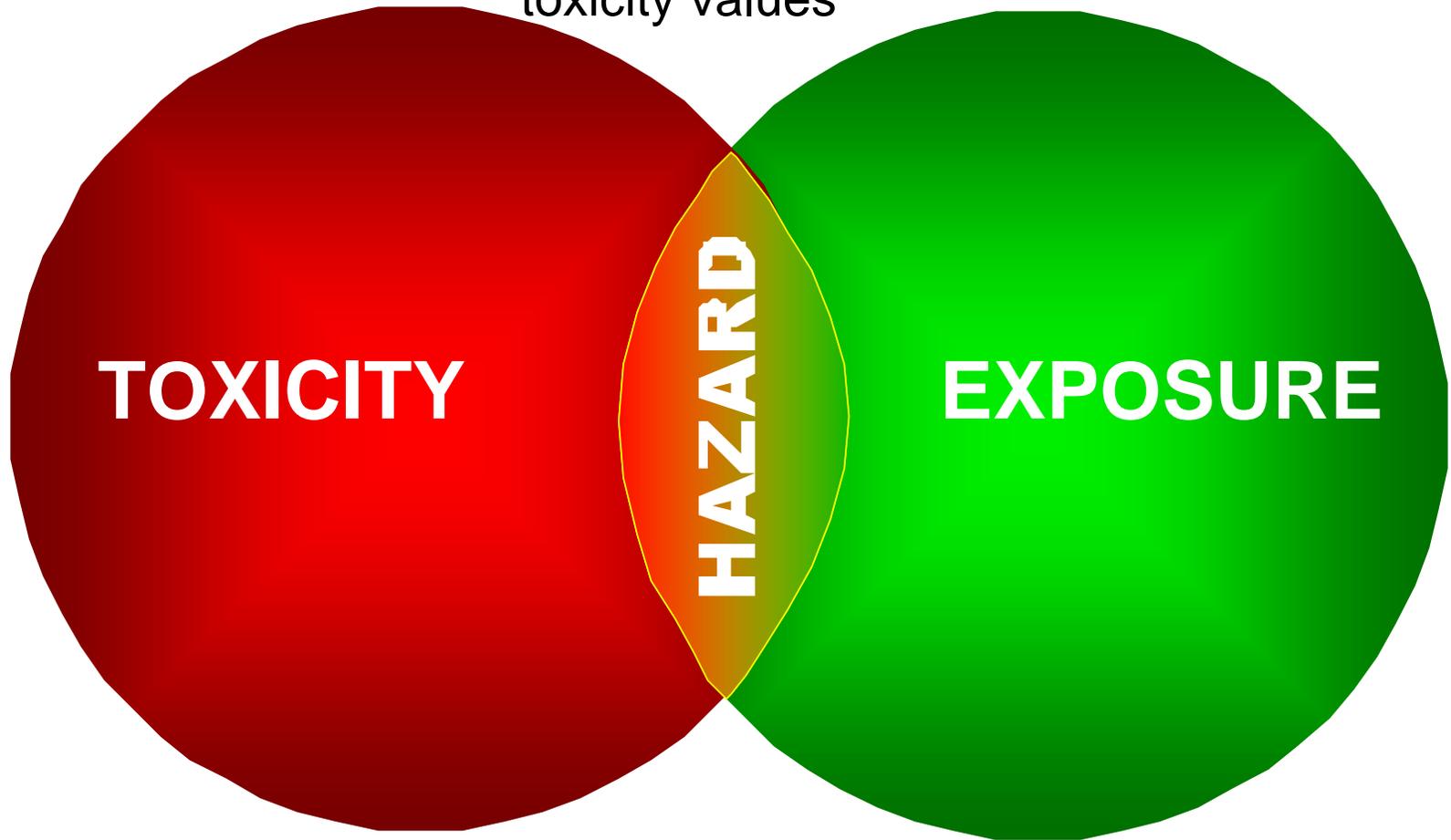
Brain et al. 2004



“All substances are poisons: there is none which is not a poison. The right dose differentiates a poison and a remedy”

PARACELSUS, 1493-1541

Assessment of hazard based on a ratio of single deterministic toxicity values



QUOTIENTS

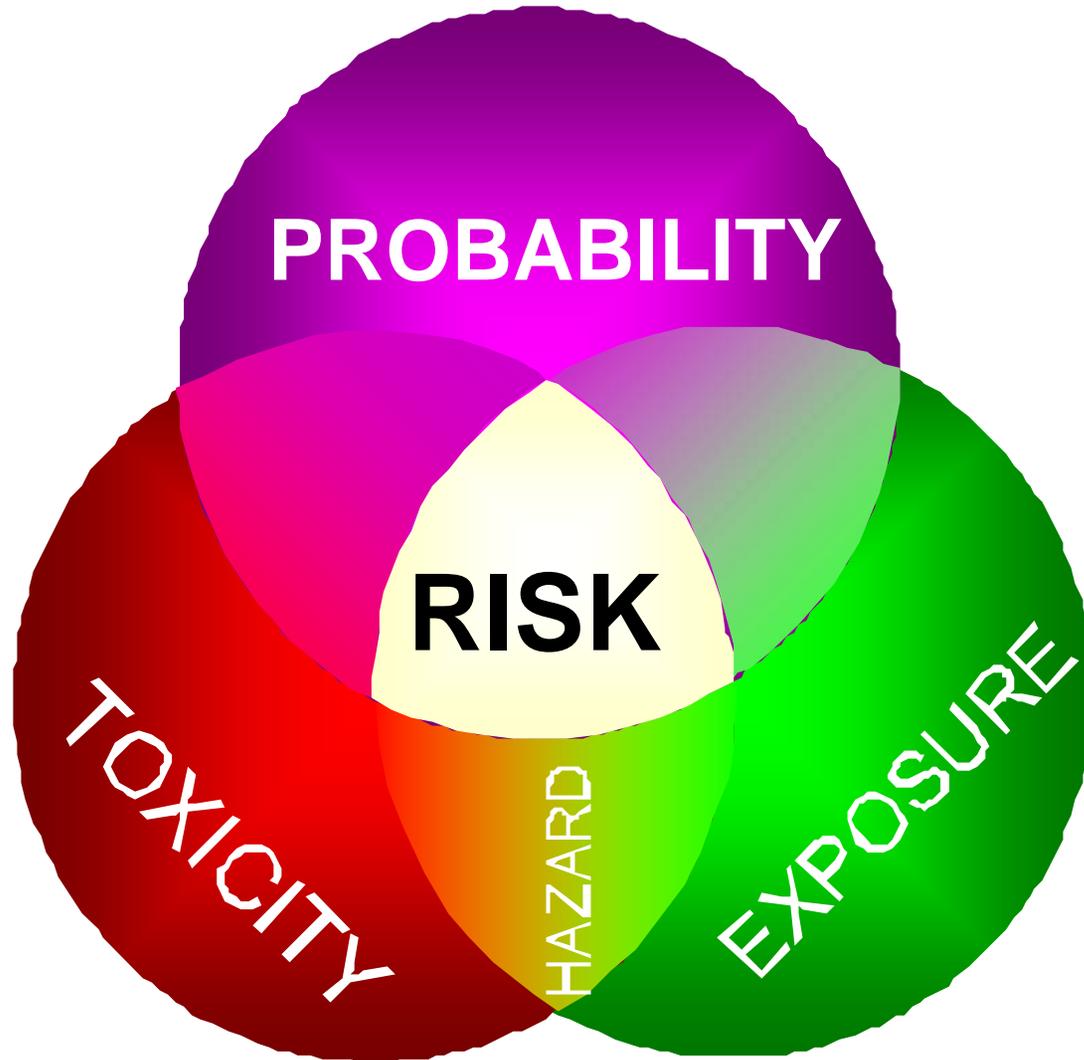
$$\text{HAZARD (LOC)} \approx \frac{\text{EXPOSURE CONCENTRATION}}{\text{EFFECT CONCENTRATION}}$$

CARL FRIEDRICH GAUß

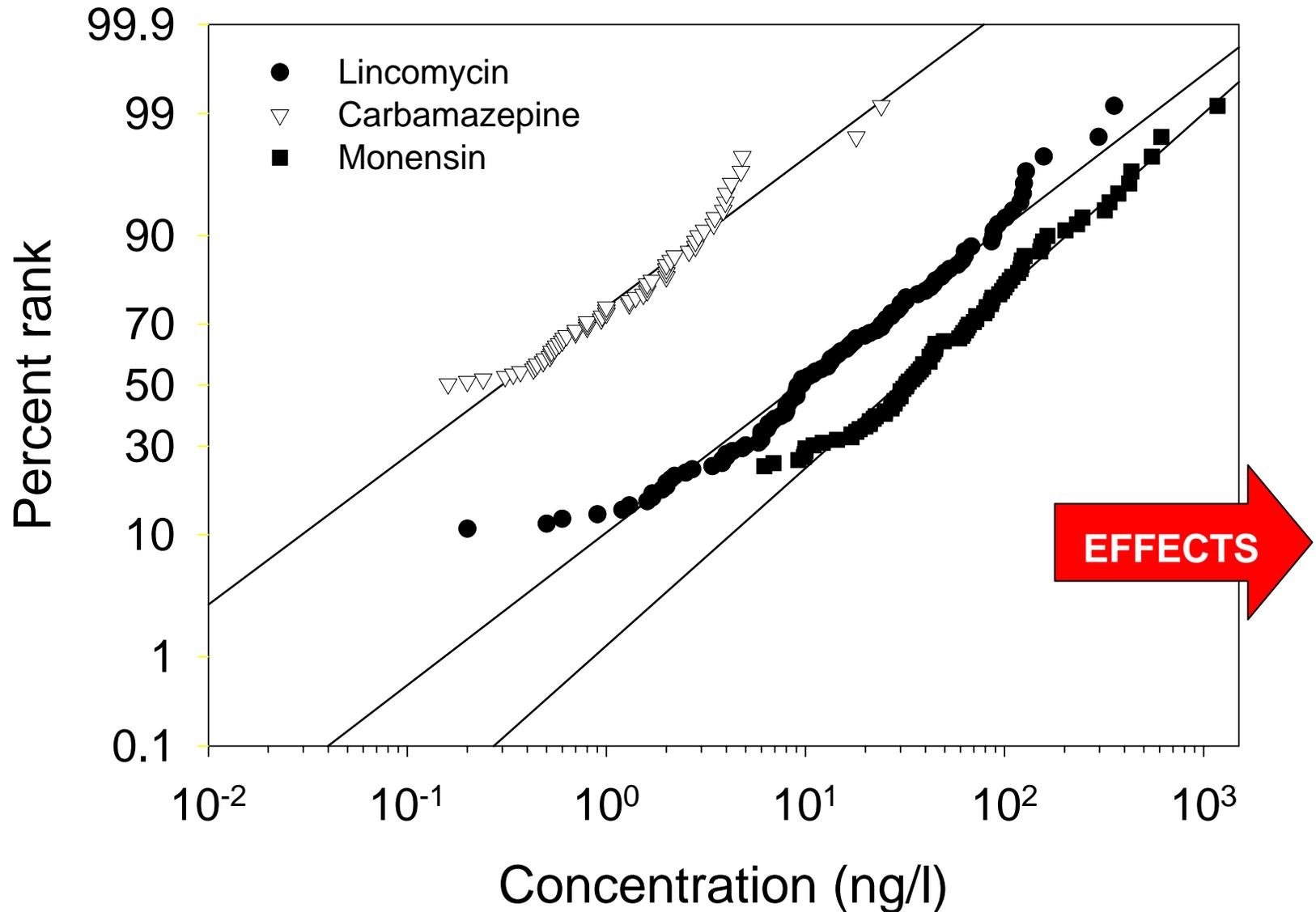
30 April 1777 - 23 Feb 1855



Assessment of risk based on likelihood of exposure and/or toxicity



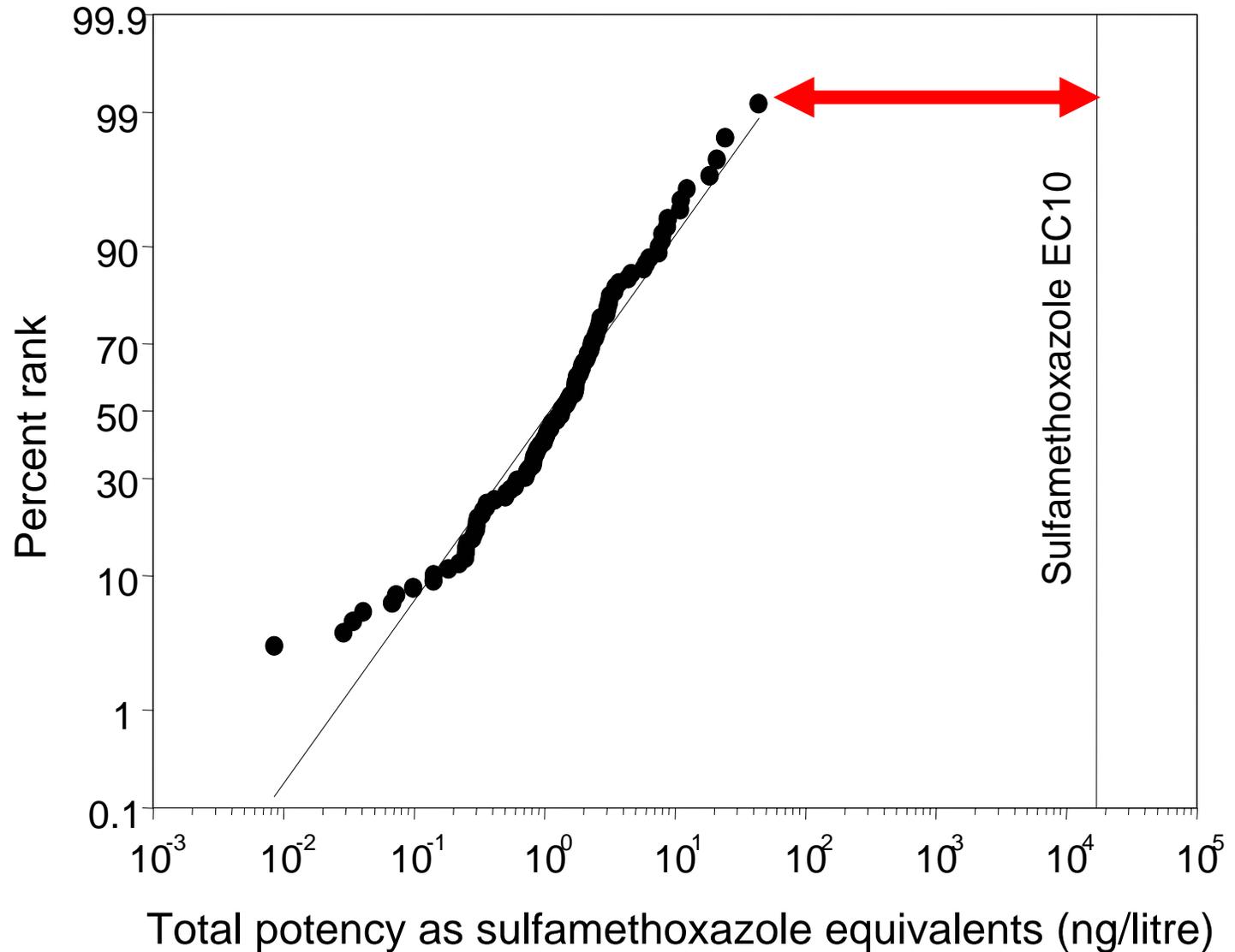
PROBABILITY OF EFFECT



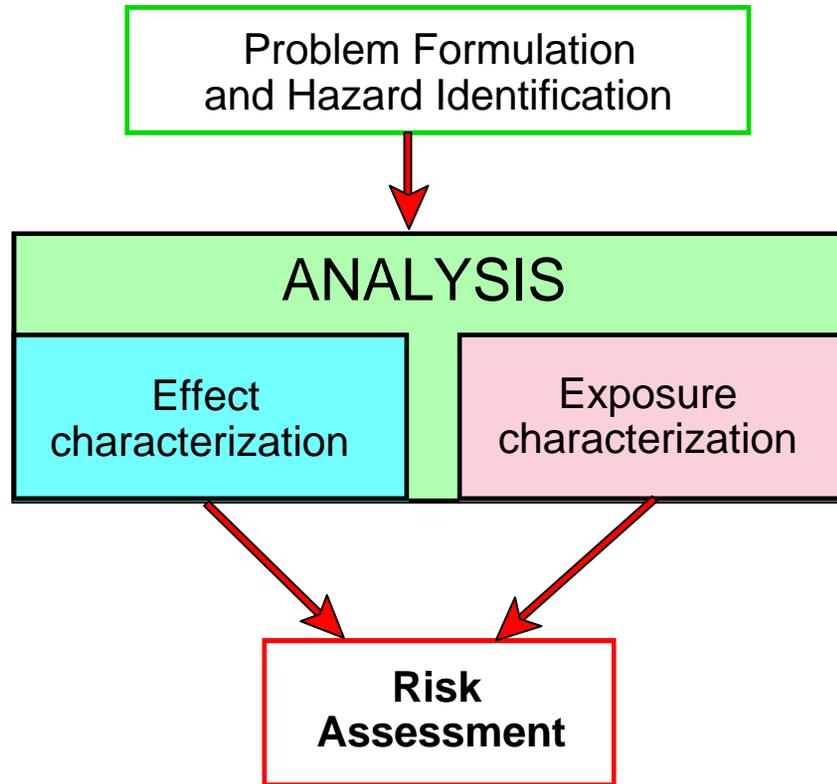
DEALING WITH MIXTURES

- Additive toxicity and using potency addition (TE).
- Whole effluent testing

TOTAL POTENCY AS TOXIC UNITS



RISK ASSESSMENT



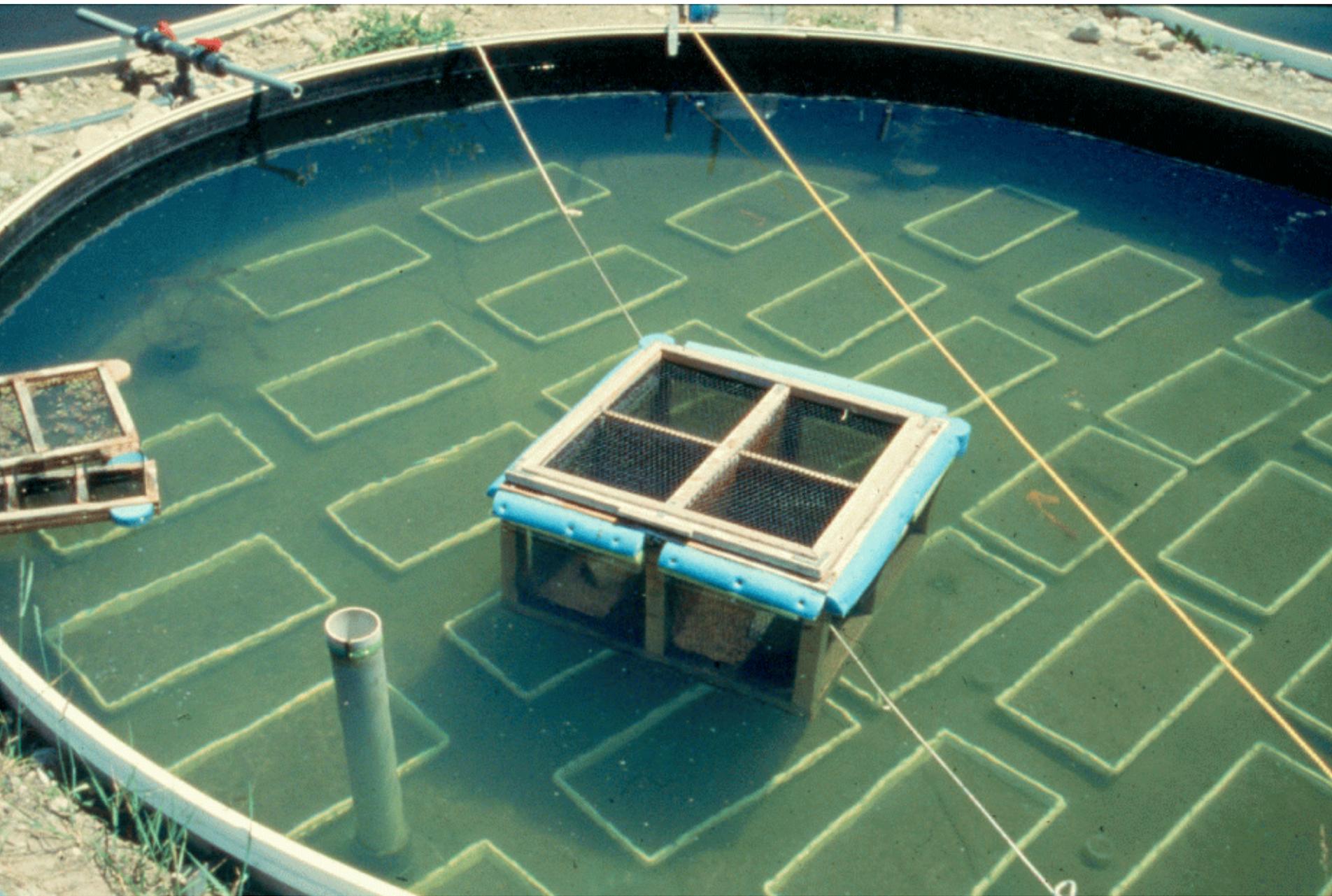
- Special considerations
 - Chronic exposures from pseudopersistence
 - Non-traditional endpoints
 - Mixtures a reality and additivity likely

AQUATIC COSMS

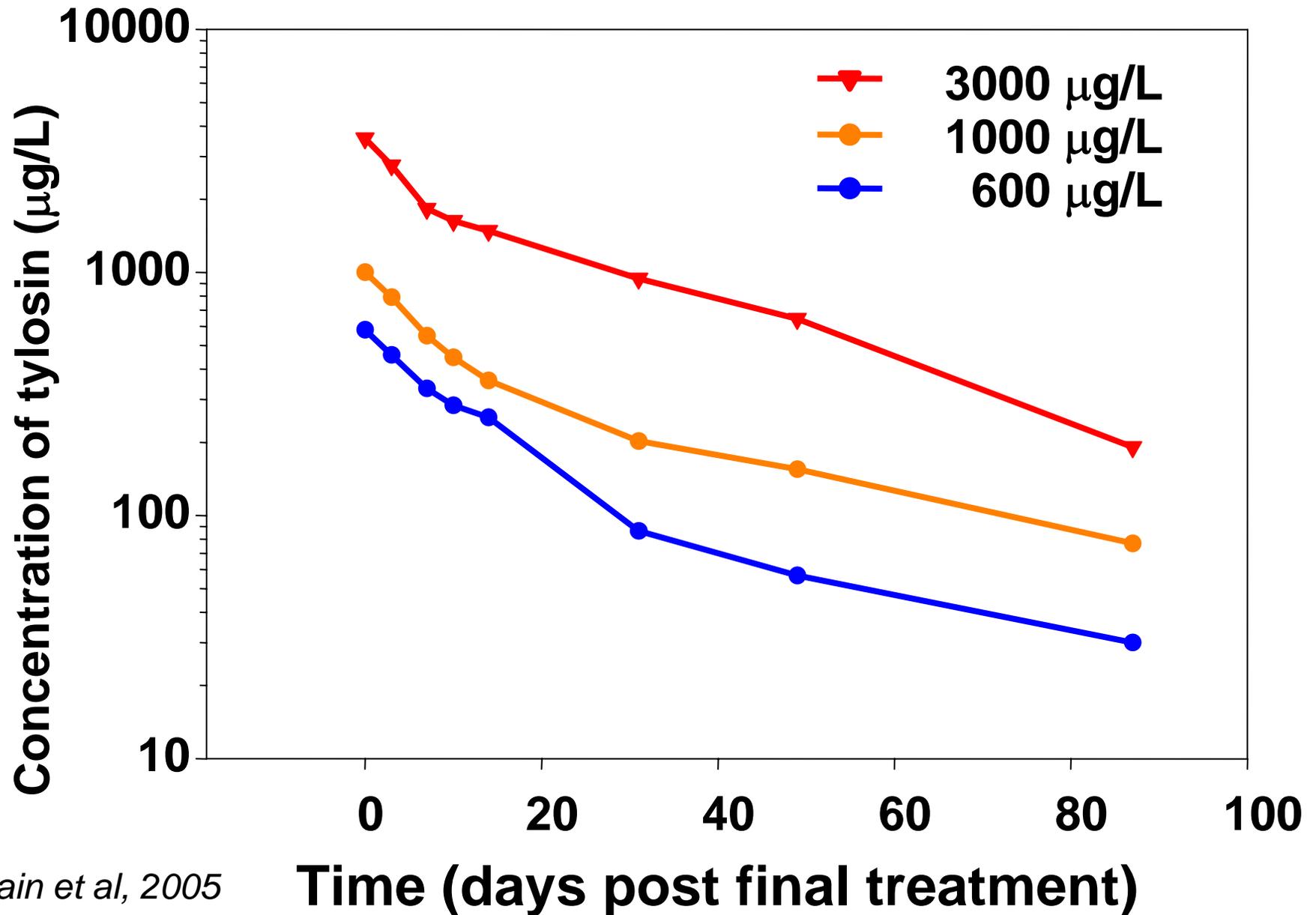


EFFECT CHARACTERIZATION IN COSMS

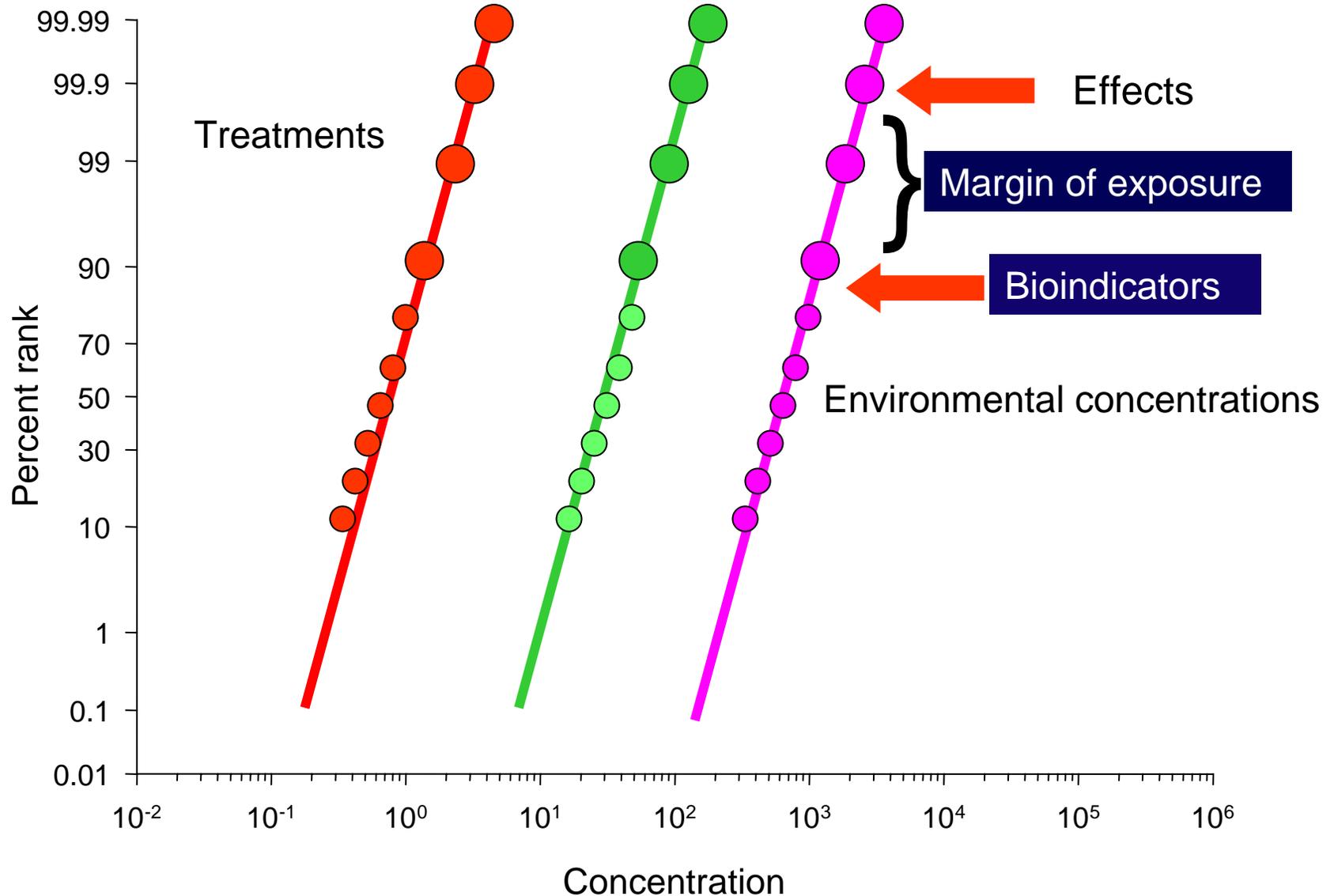
- Community-down approach - rapidly identify sensitive species in several trophic levels
- Observation of direct and indirect effects
- Structural and functional endpoints
- More realistic stressor exposure
- Range of concentrations - upper and lower thresholds - multiple species - multiple responses
- Synthetic mixtures (Whole Effluent Test)



FATE OF TYLOSIN IN AQUATIC MICROCOSMS

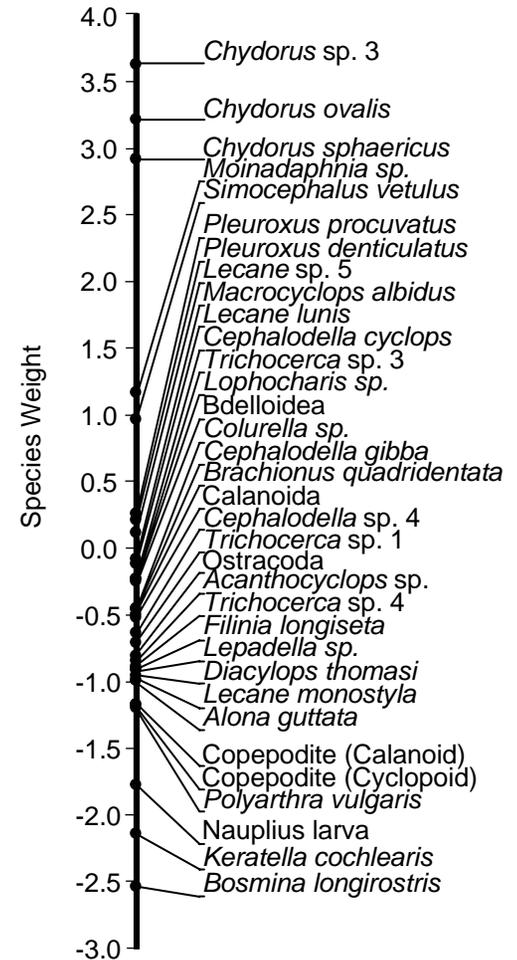
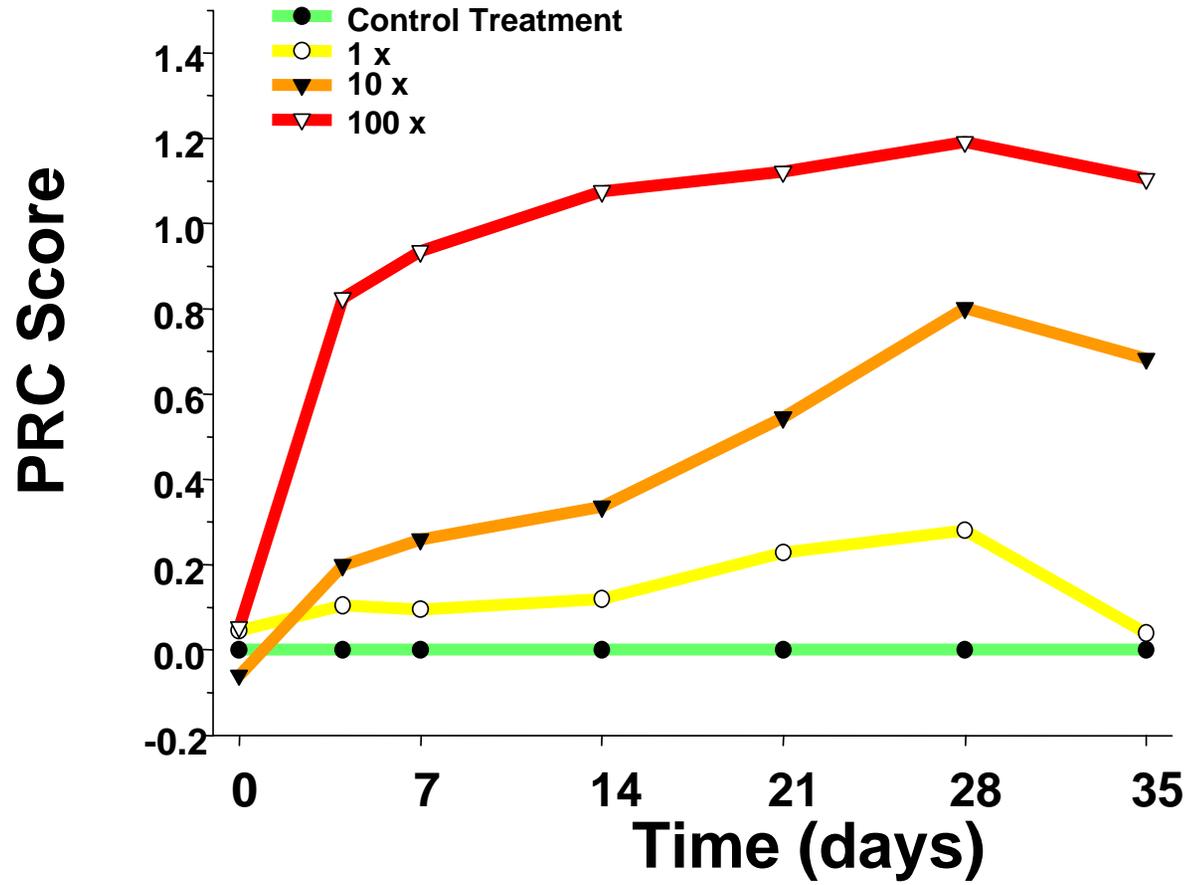


MIXTURE CONCENTRATIONS



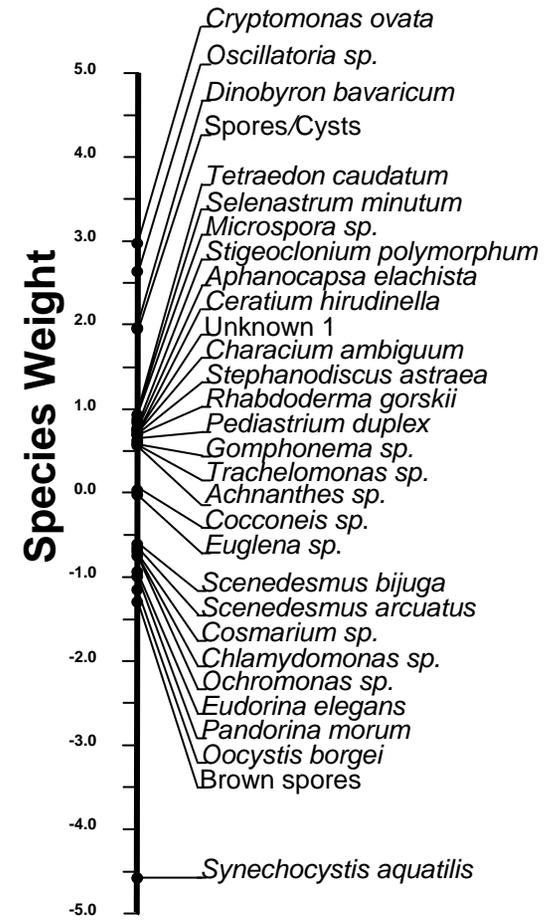
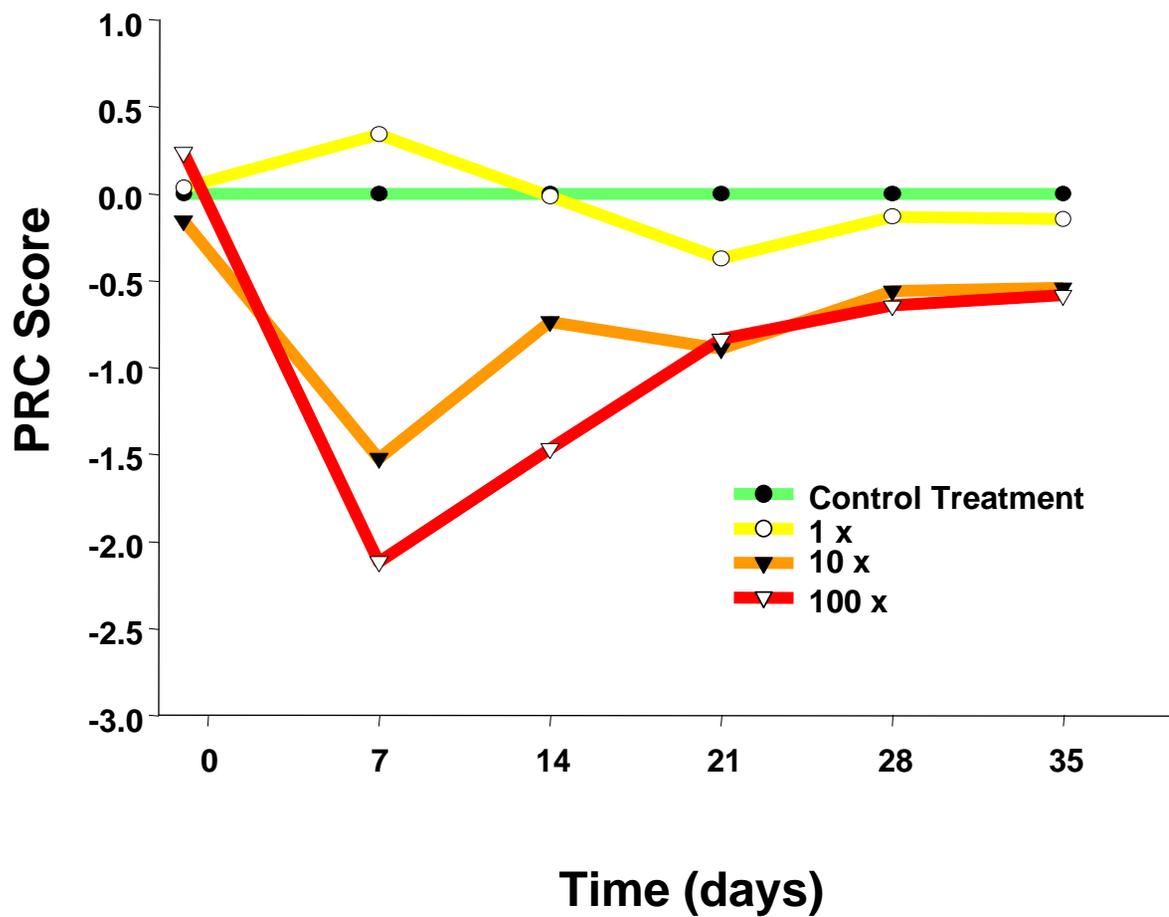
Zooplankton Community Response

Ciprofloxacin, Fluoxetine, Ibuprofen



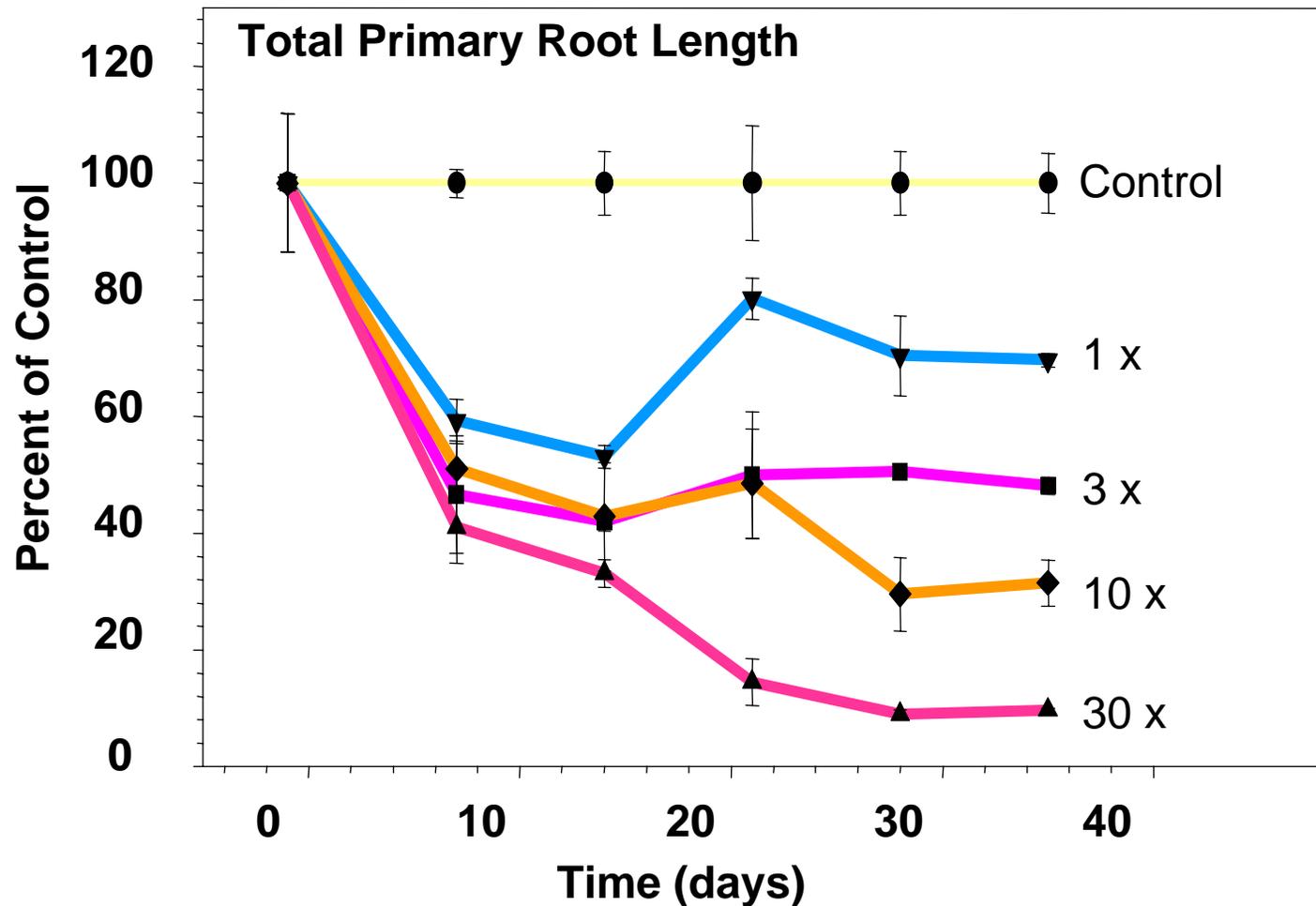
Phytoplankton Community Response

Ciprofloxacin, Fluoxetine, Ibuprofen



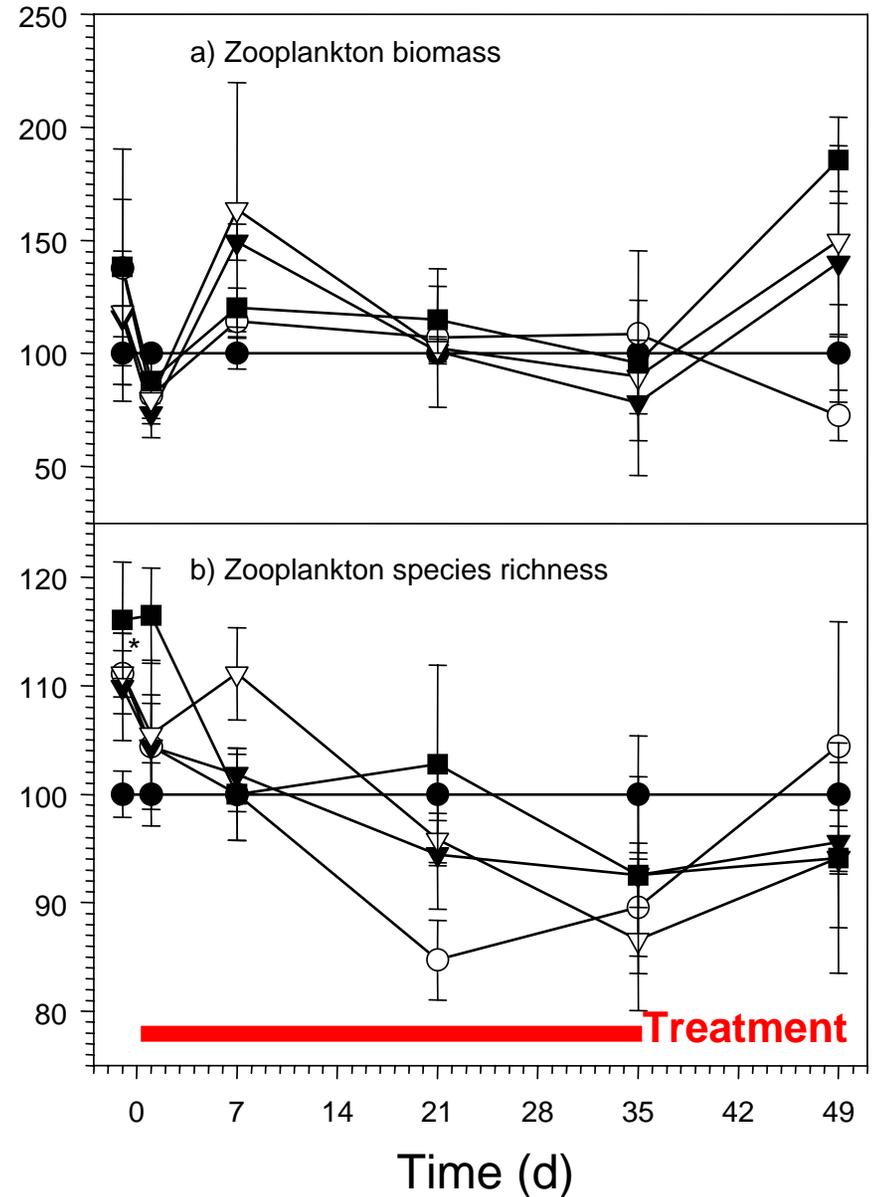
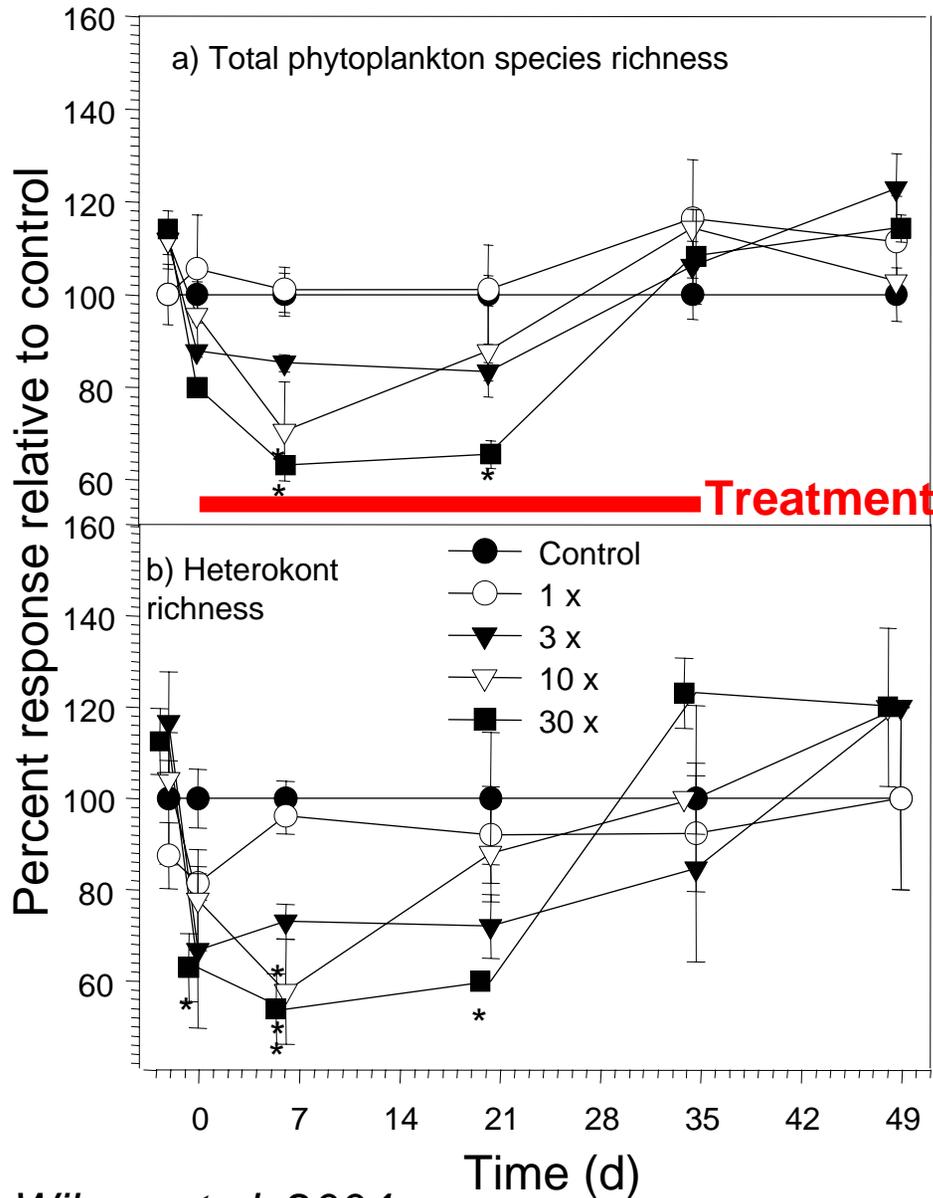
RESPONSE OF *MYRIOPHYLLUM SIBIRICUM*

Tetracycline, oxytetracycline, chlortetracycline, and doxycycline



Brain et al, 2005

RESPONSE OF PLANKTON



CONCLUSIONS

- Identifying chemicals of concern
 - Need to consider causality
- Identifying sources
 - Not always easy
- Assessing effects
 - Need to consider effects above the level of the organism
- Assessing risks of chemicals of concern
 - Cannot rely on traditional tests with traditional endpoints
- Toxicity, hazard and risk
 - Probabilistic approaches are promising
- Dealing with mixtures
 - Complex but whole effluent testing offers advantages

**THANK
YOU**

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